COURSE DATA

DATA SUBJECT

Code: 34062
Name: Organic Chemistry
Cycle: Undergraduate Studies
ECTS Credits: 12
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1201 - Degree in Pharmacy	Facultat de Farmàcia i Ciències de L'alimentació	2	Annual
1211 - Double Degree in Pharmacy and Human Nutrition and Dietetics	Facultat de Farmàcia i Ciències de L'alimentació	2	Annual

SUBJECT-MATTER

Degree	Subject-matter	Character
1201 - Degree in Pharmacy	Organic chemistry	COMPULSORY
1211 - Double Degree in Pharmacy and Human Nutrition and Dietetics	Asignaturas obligatorias del PDG Farmacia-Nutrición Humana y Dietética	COMPULSORY

COORDINATION

BALLESTEROS CAMPOS RAFAEL

SUMMARY

Knowledge of the structure and reactivity of organic compounds is essential for a good understanding of the biochemical processes, metabolism and toxicology of drugs, and their mechanism of action at the molecular level. Moreover, this knowledge is also necessary to raise the preparation of compounds that retain all their beneficial properties but not have unwanted side effects.

The course has been organized into two semesters, the first with more theoretical content than the second one. In the first half , the contents of the theoretical part of this subject have been structured around the study of the most important and frequent functional groups in organic compounds. Since students have taken chemistry courses in the first year, it will be necessary simply remember and reinforce basic concepts about the structure and types of bonds in these compounds, which students should know, showing particular attention to the intermolecular forces, so important in the processes of enzyme-substrate or drug-receptor recognition. Also we consider necessary to show how to apply to organic compounds the existing knowledge about acidity and basicity, as well as thermodynamics and kinetics in chemical reactions.

In the second half, the contents of the theoretical work will focus on basic aspects of synthetic transformations of organic compounds, and also on the application of spectroscopic techniques in the structural elucidation. At the same time, in the practical sessions conducted in the laboratory, students will start in the use of standard techniques of manipulation, isolation, identification and transformation of organic compounds.

Throughout the course, basic notions related to the contribution from organic chemistry to achieve sustainable development will be introduced, especially in relation to responsible production and consumption.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

Basic knowledge of general chemistry both at theoretical (atomic structure and chemical bonding, kinetics and thermodynamics applied to chemical processes, acidity and basicity, ..) and practical (correct use of the material commonly used in a chemistry lab, simple operations of separation, preparation of solutions, implementing the appropriate safety standards) levels. Previous knowledge of Instrumental Techniques.

COMPETENCES / LEARNING OUTCOMES

-

Act with autonomy in learning, making informed decisions in different contexts, issuing judgements based on experimentation and analysis, and transferring knowledge to new situations.

Apply the basic techniques for obtaining, isolating and characterising organic compounds.

Apply the general rules of nomenclature for organic compounds, including stereochemistry.

Be able to design syntheses of simple organic compounds from specific starting materials involving more than one reaction.

Collaborate effectively in work teams, assuming responsibilities and leadership roles and contributing to collective improvement and development.

Contribute to the design, development and implementation of solutions that respond to social demands, taking into account the Sustainable Development Goals as a reference.

Demonstrate critical and self-critical thinking in the field of the degree programme, considering aspects such as professional ethics, moral values and the social implications of the different activities carried out.

Know and understand, within the field of the degree programme, gender inequalities in society; integrate different needs and preferences based on sex and gender into the design of solutions and problem solving.

Know and use the different types of representation of organic molecules.

Know how to communicate effectively, both orally and in writing, adapting to the characteristics of the situation and the audience.

Know how to interpret, evaluate and communicate relevant data in the different areas of pharmaceutical activity, using information and communication technologies.

Know how to relate the presence of functional groups in molecules to their reactivity in different processes (substitution, elimination, addition, hydrolysis, oxidation, reduction, etc.).

Know the different functional groups present in organic molecules and relate the presence of functional groups to the physicochemical properties of organic molecules.

Know the mechanisms of the most important chemical transformations.

Know the most common methods for obtaining different types of compounds.

Know the risks associated with the use of organic compounds and the techniques employed in their handling, production, isolation, purification and analysis.

Module: Chemistry. Know and apply the main techniques of structural research, including spectroscopy.

Module: Chemistry. Know and understand the characteristic properties of elements and their compounds, as well as their application in the pharmaceutical field.

Module: Chemistry. Know and understand the nature and behaviour of functional groups in organic molecules.

Propose creative and innovative solutions to complex situations or problems within the field of knowledge, to respond to diverse professional and social needs.

Recognise one's own limitations and the need to maintain and update professional competence, placing particular emphasis on self-learning of new knowledge based on available scientific evidence.

Recognise the types of bonds that may be present in organic compounds.

Search for and find knowledge related to the area, always applying critical and self-critical thinking.

Transmit ideas, analyse problems and solve them with critical spirit, acquiring teamwork skills and assuming leadership when appropriate.

Understand and predict the behaviour of organic compounds in different environments (chemical, biological, environmental, etc.).

Understand the general reactivity of the most important functional groups present in organic molecules.

DESCRIPTION OF CONTENTS

1. Basic concepts: Structure, reaction mechanisms.

Part I: 10h.

STRUCTURE AND BONDING IN ORGANIC COMPOUNDS.- Introduction .- Functional Groups .- Structural formula and systematic nomenclature .- Lewis Formula.- Molecular Geometry .Covalent bond in carbon compounds. Polarity in organic molecules.- Aromaticity:- Intermolecular Forces.- Molecular models.

REACTION MECHANISMS.- Types of organic reactions .- Thermodynamics and kinetics.- Profiles and reaction mechanisms .- Polar reactions: nucleophile and electrophile.- Radical reactions Reaction intermediates: radicals, carbanions, carbocations and carbenes.

ACID-BASE REACTION IN ORGANIC COMPOUNDS.- Structural and electronic factors influencing the acidity and basicity: inductive effect, conjugation and aromaticity. Polyfunctional acids and bases.- Amphoteric compounds .- Aminoacids.- Influence of pKa in the absorption of drugs.

2. Hydrocarbons;Stereochemistry.

Part II: - 10 h.

ALKANES AND CYCLOALKANES .- Structure.- Physical Properties .- Conformational analysis of ethane and butane .- Cycloalkanes .- Ring Strain.- Cyclohexane.- Substituted cyclohexanes: cis-trans isomerism.- Bigger cycloalkanes and polycyclic alkanes.- Steroids.- REACTIVITY: Combustion.- Halogenation of alkanes: mechanism.-Relative stability of radicals.

STEREOCHEMISTRY Stereoisomers .- Conformational and configurational isomers.- Stereogenic centers.- Optical and geometric isomers .- Convention E-Z in alkenes.- Chirality:- Optical activity.- Racemates .- The rule RS : Nomenclature of enantiomers: .- Fischer projections .-D and L Configurations - Compounds containing more than one stereocenter.- Diastereomers .- Meso compounds.- Resolution of a racemic mixture.

ALKENES, ALKYNES AND CONJUGATED SYSTEMS .- Physical properties of alkenes.- Relative stabilities of alkenes. -Reactivity: Polar addition of symmetrical and unsymmetrical electrophiles.- Stability of carbocations .- Regioselectivity - Catalytic hydrogenation.- Oxidation .- Reactions of alkynes.- Acidity of terminal alkynes .- Electrophilic addition in conjugated systems.

AROMATIC COMPOUNDS.- Benzene.- Nomenclature of substituted benzenes.- Aromatic and heteroaromatic rings.- Electrophilic aromatic substitution. Halogenation, nitration and sulfonation .- Friedel-Crafts reaction .- Activation and deactivation of the benzene ring .- Orientation in electrophilic aromatic substitution.- Nucleophilic aromatic substitution. -Polycyclic aromatic hydrocarbons.- Reactivity of the benzyl system.

Part III: 12h

HALOGENATED ORGANIC COMPOUNDS .- Structure and physical properties of haloalkanes .- Nucleophilic Substitution.- Synthetic applications .- SN1 and SN2 mechanisms.- Dehydrohalogenation: Elimination

3. Compounds with simple carbon-heteroatom bond

Part III: 12h
Reaction Mechanisms .- E1 and E2 mechanisms.- Competition between substitution and elimination. - Some applications of halogenated derivatives.- Organometallic reagents: Structure and reactivity.

ALCOHOLS, PHENOLS AND THIOLS .- Structure and physical properties of alcohols .- Nomenclature of alcohols and phenols Acidity and basicity .- Preparation of alkoxides and carbocations .-Alcohol dehydratation .- Transformation in haloalkanes and sulfonates .- Oxidation of alcohols, diols and phenols. Thiols: properties and reactivity.- Biological importance.

ETHERS, EPOXIDES AND SULFIDES .- Nomenclature and physical properties.- Cyclic ethers as solvents.- Reactions .- Epoxides: ring opening reactions.- Sulfides: structure, synthesis and applications.

AMINES AND OTHER NITROGENATED COMPOUNDS .- Structure .- Nomenclature .- Physical properties.- Acidity and basicity of amines .- Aromatic amines.- Arenodiazonium salts as intermediates in organic synthesis.

4. Compounds with carbon-heteroatom multiple bonds

Part IV: 10h.

ALDEHYDES AND KETONES. THE CARBONYL GROUP. Nomenclature of aldehydes and ketones.- Structure of the carbonyl group.- Nucleophilic addition to the carbonyl group.- Addition of water and alcohols: acetals and hemiacetals, cyclic sugars.- Addition of carbon nucleophiles .- Addition of amines and related compounds .- Reduction and oxidation. Enols and enolates.

CARBOXYLIC ACIDS AND THEIR DERIVATIVES.- Nomenclature .- Structure .-Physical Properties .- Acidity and basicity of carboxylic acids and carboxylic acid derivatives .- Reactivity of the carboxylic group: the addition-elimination mechanism.- Transformations between carboxylic acid derivatives: acyl halides, anhydrides, esters and amides .- Reactions of carboxylic acid derivatives.

NITRILES AND ISOCYANATES. General structure and reactivity. .- CARBAMATES.- Aminoacids,peptides and proteins.-

SIMPLE AROMATIC HETEROCYCLES: Pyridine and pyrrole. Fused heteroaromatic rings: Indole,quinoline and isoquinoline.- Heterocycles with two or more heteroatoms.

5. Design and synthesis of simple organic compounds

Part V:

INTRODUCTION TO ORGANIC SYNTHESIS. Planning a synthesis. The disconnection approach. Synthesis strategies. Species with electrophilic and species with nucleophilic carbon.

CHEMOSELECTIVITY AND PROTECTING GROUPS. Protecting groups of alcohols and amines.-Carbonyl protecting groups. Examples.

6. Laboratory sessions

Part VI: 20h
- Safety in the organic chemistry laboratory.
- Introduction to the experimental techniques for the separation and purification and identification of organic compounds
- Experiments in organic synthesis
- Identification of the obtained products

7. PRACTICAL SESSIONS OF SEMINARS

Block VII: 8h
STRUCTURAL ANALYSIS OF ORGANIC COMPOUNDS. Application of the techniques of mass spectrometry, UV-visible, IR and NMR to the determination of the structures of simple organic compounds.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	6,00
Theory	58,00
Seminar	36,00
Laboratory	20,00
Total hours	**120,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	14,00
Independent study and work	8,00
Preparation of lessons	114,00
Preparation for assessment activities	40,00
Resolution of case studies	0,00
Total hours	**176,00**

TEACHING METHODOLOGY

Lectures. The professor will introduce the topics under study,particularly those aspects of particular complexity,using the most suitable tools of information and communication. The professor will indicate the points for the students to review prior to attending each class. Student participation will be encouraged.

Practice problems. These classes will address the application of the topics introduced in the lectures. The students should have worked the problems out in advance. The professor will guide the problem solving

work, which should preferably be discussed by the students, either in groups or individually. These classes require substantial student's personal work. 28 hours.

Tutorials. Students will attend in small groups. The professor will solve the doubts and guide students on the most useful methods for studying the different topics and solving the problems. The teacher may raise issues, specific exercises or written jobs to beworked out by the students.The teacher will evaluate the process of learning in a global way.

Seminars. Seminars can be used for the introduction to the spectroscopic techniques and their application to the structural determination. Complementary activities (management of drawing programs and computer modeling, molecular models, discussion of current issues etc.) may also be carried out as well. 8 hours.

Laboratory. Introduction to the organic chemistry laboratory. The student will learn the basic experimental techniques for the preparation, isolation and purification of simple organic compounds, and also the risks associated with handling and use of these products and techniques, trying to reduce the negative effects on the environment and on people.

EVALUATION

The assessment of student learning will take into account all the aspects outlined in the methodology described above.

- 10% of the grade will come from direct evaluation of teacher in classes and tutorials. In this evaluation different aspects shall be taken into account:

* participation in the discussions raised in classes;

* progress in the use of the organic chemistry language;

* ability to solve problems and ask questions;

- 5% of the grade will be obtained from the participation and the work developed in the seminars;

- 15% of the note corresponds to the attendance and participation in practical classes at the laboratory. Attendance to these activities is required to pass the course. Students that have already succeded practical sessions are not forced to do it again.

The evaluation of the laboratory work will consider:

*Experimental skills, participation and observation of the safety rules (40%).

*Preparation in advance of the laboratory work, and laboratory notebook (20%).

*Exam on the experimental techniques (40%).

- 70% of the grade will be obtained from the examinations results. The exams will be coordinated by the professors of the different groups, although they will not be necessarily identical.

Exams: one exam in the first semester and one in the second semester. In order to pass the course the student must obtain a score equal to or greater than 4.5/10 in each exam. The final note will sum up the exam score plus the marks corresponding to practical classes, seminars and direct evaluation. The global score must be 5/10 or higher for the student to pass the course.

The scores obtained in the partial exams will not be maintained for the second final exam. In the case that the student had performed the scheduled activities (practical classes, seminars) but failed to attend the final exam, he/she will be considered "No presentado" in the first round and "Suspenso" in the second one.

quot;\"\"\"\"en-GB\"\"\"\"\"\"\"\"\"\"\"\"\"\"\"\"\"\"">The scores obtained in the partial exams will not be maintained for the second final exam. In the case that the student had performed the scheduled activities (practical classes, seminars) but failed to attend the final exam, he/she will be considered "No presentado" in the first round and "Suspenso" in the second one.

REFERENCES

- K. P. C. Vollhardt, N.E. Schore. Química Orgánica (5ª ed.). Ed. Omega (2007).
- F.A. Carey. Química Orgánica. (6ª ed.) Mc Graw-Hill (2006).
- L. G. Wade Jr. Química Orgánica, vols 1 y 2 (7ª ed.). Ed. Pearson Educación, México (2012).
- J.R. Pedro y G. Blay 200 Problemas de Determinación estructural de Compuestos Orgánicos. Ed Visión Libro 2010 (Madrid)
- W.R. Peterson. Nomenclatura de las sustancias químicas (5ª edición).Ed. Reverte (2020).
- P. Yurkanis Bruice Química Orgánica (5ª ed.). Ed. Pearson Prentice Hall (2008).
- D. Klein, Química Orgánica (1ª ed.) Ed. Panamericana (2012).
- J. McMurry, Química Orgánica(8ª ed.)Ed.Cengage Learning, 2012.
- F. García Calvo-Flores, J. A. Dobado Jiménez, Problemas resueltos de Química Orgánica, (1ª edición) Ed. Paraninfo. 2007.

- J. Smith, Organic Chemistry with Biological Topics. (6ª edición). Ed. McGraw-Hill.

- ChemBioOffice Ultra, PerkinElmer (CambridgeSoft) (Amplia selección de aplicaciones y funcionalidades que permite estudiar, dibujar, formular, modelar y editar estructuras moleculares químicas y biológicas."